SECTION 12- FEMUR ASSEMBLY

12.1 Femur Assembly Description and Features

The femur assembly of the THOR dummy is a representation of the human femur, the largest bone in the human body. This assembly extends from the femur ball joint to the knee. At the upper end of the femur is a ball which mates with the socket in the pelvis assembly to form the hip joint. The THOR femur is interchangeable with the Hybrid III femur and can be used to retrofit an older dummy. At the lower end of the femur is the standard femur load cell which will connect the femur assembly to the Hybrid III knee. **Figure 12.1** shows a drawing of the femur assembly without the Femur Ball Joint (T1FMM100) that connects the femur shaft hub to the pelvis.

The THOR femur has been designed with an axial-compliant bushing that has been tuned to create a biofidelic deflection along the axis of the femur during an impact. The axial compression of the femur has been designed to simulate the compressive response of human cadaver femurs. The compliant section is constrained on a shaft that slides linearly within the bushing. Several perimeter bolts constrain the bushing to a purely linear motion within the bearing and resist torsion and rebound separation.

Each femur is instrumented with a six-axis Femur Load Cell (Denton: Model B-1953). This load cell is also used in the Hybrid III dummy. This sensor produces output for three degrees of applied forces and three moments around the orthogonal axes.

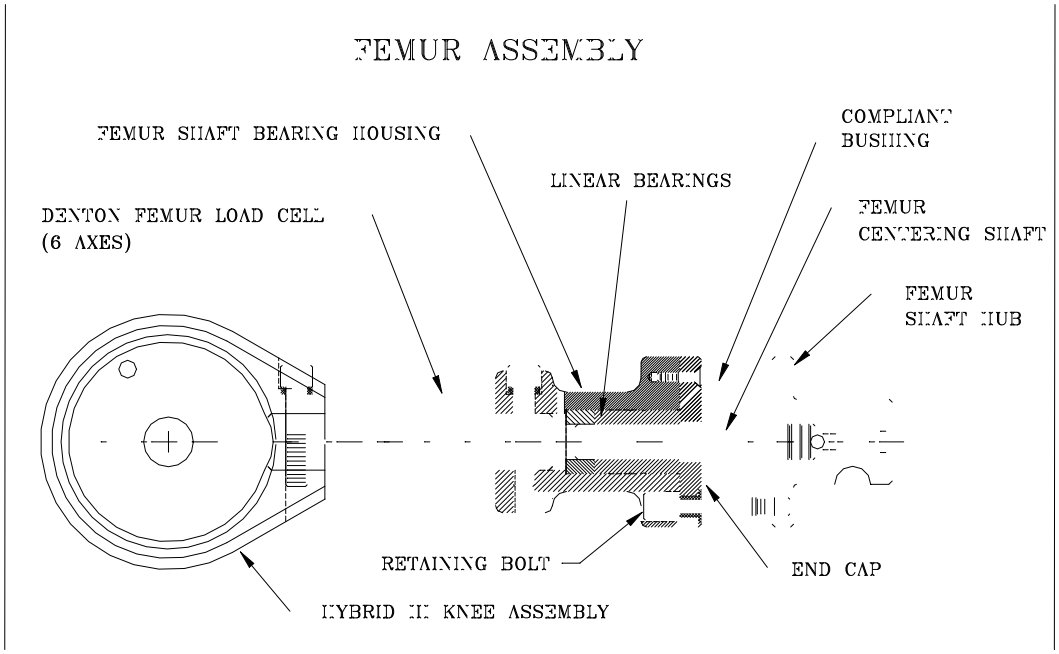

Figure 12.1- Femur assembly

12.2 Assembling the Femur

12.2.1 Parts List

The parts list and all quantities for the femur assembly are listed in Appendix I - Bill of Materials under the Femur subsection. Refer to drawing T1FMM000 in the THOR drawing set for a detailed mechanical assembly drawing. **Figure 12.2** is a drawing of the exploded mechanical femur assembly (T1FMS011) needed for this assembly. The Femur Skin and its assembly to the mechanical femur is shown in Figure 12.11. In addition, the Femur Ball Joint Assembly (T1FMM100) is not shown in the figure below. The Femur Ball Joint Assembly is shown in the Pelvis section of this manual for assembly purpose but is considered to be part of the Femur Assembly in the Thor drawing package.

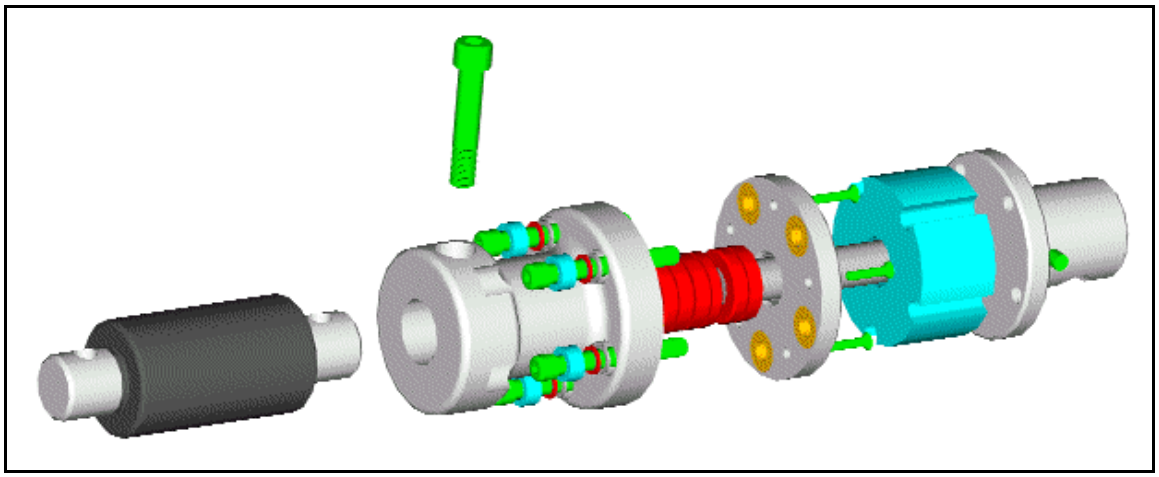

Figure 12.2- Exploded femur assembly

11.2.2 Assembling Femur Components

The following procedure is a step-by-step description of how to assemble the femur components. The numbers provided in ( ) refer to a specific drawing / part number of each part. The numbers noted in { } after the bolt size indicate the hex wrench size required to perform that assembly step. All bolts should be tightened to the torque specifications provided in Section 2.1.3- Bolt Torque Values.

1. Slide the Compliant Bushing (T1FMM014) over the Femur Shaft Assembly (T1FMM012 & T1FMM016) and seat it against the femur shaft hub, as shown in **Figure 12.3**.

Figure 12.3- Femur bushing installed over femur shaft

2. Install the femur shaft into the Shaft Bearing Housing (T1FMM010). The end of the shaft bearing housing with the linear bearings and the End Cap (T1FMM011) should be positioned closest to the femur shaft hub. The orientation of the femur shaft hub to the shaft bearing housing is critical to proper assembly. The 5/8" counter bored hole on the femur bearing housing indicates the top of the assembly. The 5/16" radius groove indicates the bottom of the shaft hub. The proper orientation of these pieces is shown in **Figure 12.4**.

Figure 12.4- Orientation of housing and hub

3. Align the grooves in the compliant bushing with the corresponding holes in the femur hub and the bearing housing, as shown in **Figure 12.5**.

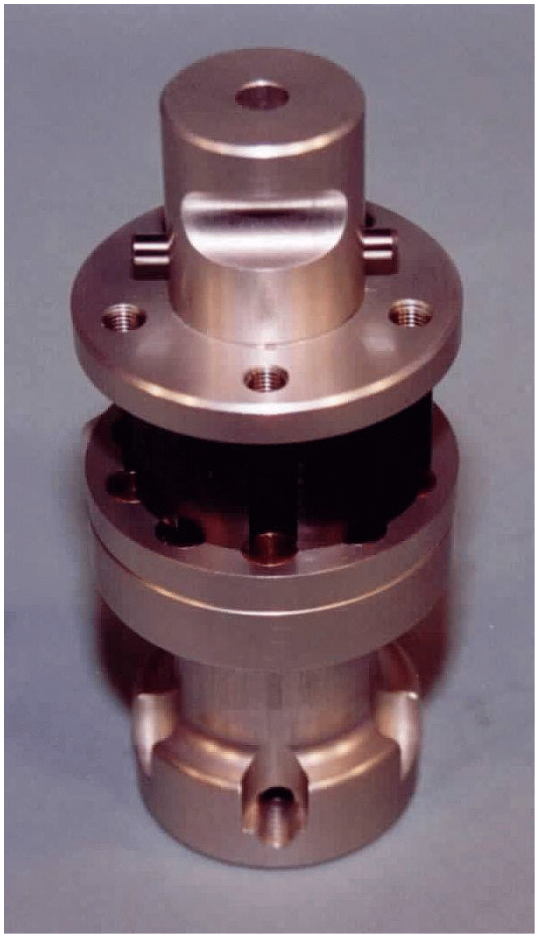

Figure 12.5- Bolt hole alignment

4. Place the following hardware on each of five 5/16-24 x 2.25" SHCS {1/4} in the order listed: a Hard Fiber Washer (O.D. 7/16", I.D. 5/16") a Steel Flat Washer (T1FMM021), and a Bolt Bushing (T1FMM017). Insert each bolt through the counter bored holes of the bearing housing toward the shaft assembly. Tighten the five bolts ½ a rotation past contact between the bolt head and the bore. This is shown in **Figure 12.6**.

Figure 12.6- Bolt assembly and orientation

5. Insert one end of the six-axis Femur Load Cell (T1INM350) into the bearing housing. Secure the load cell in the bearing housing using one Femur Load Cell Bolt (T1FMM019) {5/16} and a 5/16" lock washer, as shown in **Figure 12.7**.

Figure 12.7- Femur Load cell attachment

6. Repeat the above procedure for the right Femur.

12.2.3 Attaching the Femur to the Pelvis

The following procedure is a step-by-step description of how to attach the completed Femur Assembly (T1FMM000) to the completed Pelvis Assembly (T1PLM000). The numbers provided in ( ) refer to a specific drawing / part number of each part. The numbers noted in { } after the bolt size indicate the hex wrench size required to perform that assembly step. All bolts should be tightened to the torque specifications provided in Section 2.1.3- Bolt Torque Values.

1. At this point, it is desired to attach the left Femur Assembly to the left Femur Ball Joint (T1FMM100) that was previously attached to the Pelvis Assembly in Section 11. Before proceeding, check to ensure that the rubber O-ring is in place over the end of the femur shaft hub, as shown in **Figure 12.8**.

NOTE: The O-ring is needed to eliminate noise caused by metal to metal contact during impact at the femur joint.

Figure 12.8- O-ring installation

2 Insert the femur assembly into the femur ball joint and secure with a Femur Ball Joint Bolt (T1FMM022) {5/16} and a Delrin Washer (T1FMM020), as shown in **Figure 12.9.**

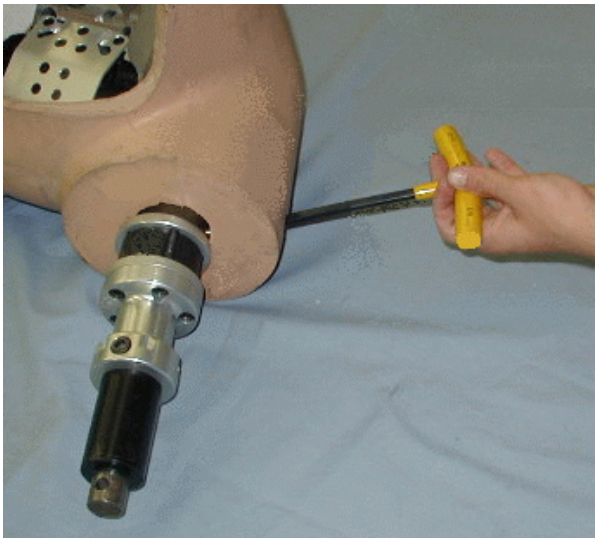

Figure 12.9- Femur assembly attached to femur ball joint

3. Wrap the left Femur Skin (T1FMS011) around the femur assembly and rotate to align the holes and knobs at the knee skin interface. Secure the skin in place with the zipper on the lateral side of the leg, as shown in **Figure 12.10**.

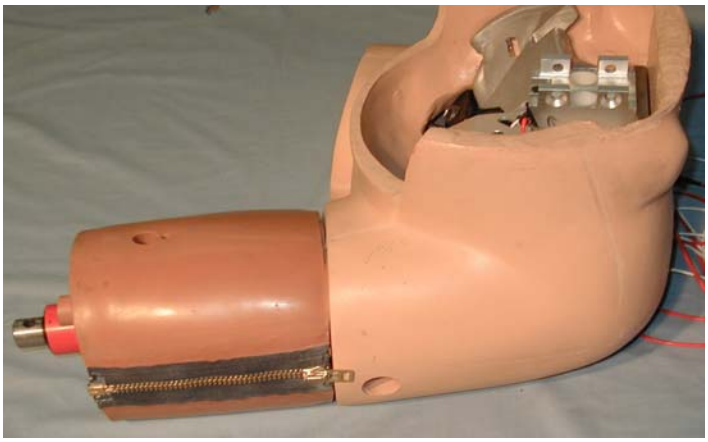

Figure 12.10- Proper Installation of femur skin

NOTE: The end of the femur skin with the two knobs is oriented toward the knee flesh. The 1/4" wire groove at the knee flesh interface is provided to route the femur load cell wires downward.

4. Repeat Steps 1thru 3 for the right femur assembly.

12.2.4 Attaching the THOR-LX to the Femur

The following procedure is a step-by-step description of how to attach the completed THOR-LX Assembly (T1LXM000) to the completed Femur Assembly (T1FMM000). The numbers provided in ( ) refer to a specific drawing / part number of each part. The numbers noted in { } after the bolt size indicate the hex wrench size required to perform that assembly step. All bolts should be tightened to the torque specifications provided in Section 2.1.3- Bolt Torque Values.

1. At this point, the Right Lower Extremity Assembly is attached to the distal end of the right femur at the 6 Axis Femur Load Cell. Using a 3/8" lock washer and a Femur Load Cell Bolt (T1FMM019) {5/16}, secure the right lower extremity assembly to femur as shown in **Figure 12.11**.

Figure 12.11- Attaching THOR-LX to the Femur

2. Repeat this procedure for attaching the left lower extremity to the left femur.

12.3 Adjusting the Femur Assembly

The femur assembly does not require adjustment.

12.4 Wire Routing and Electrical Connections

The wire routing for the instrumentation in the femur assembly is fairly straightforward. Each instrument in this assembly will be covered individually.

Six-Axis Femur Load Cells: The wires from the femur load cells must be routed in the grooves provided in the femur flesh at the knee / femur interface. These wires are routed to the backside of the femur assembly.

12.5 Femur Certification

The femur assembly is certified by the manufacturer using a dynamic impact test. The purpose of this test is to verify the performance of the Compliant Femur Bushing. The impact is targeted at the knee assembly of a fully assembled dummy. The direction of impact is in line with the femur assembly. Certification procedures for this test are described in the THOR Certification Manual- available from the manufacturer as a separate publication.

12.6 Inspection and Repairs

After a test series has been performed, there are several inspections that may be made to ensure the dummy's integrity has remained intact. Use good engineering judgement to determine the frequency of these inspections; however, the manufacturer recommends a thorough inspection after twenty tests have been performed. Inspection frequency should increase if the tests are particularly severe or if unusual data signals are being recorded. Both electrical and mechanical inspections are most easily carried out during a disassembly of the dummy. Femur component disassembly can be performed by simply reversing the assembly procedure.

12.6.1 Electrical Inspections (Instrumentation Check)

Begin with the visual and tactile inspection of all instrument wires from the neck instrumentation. The wires should be inspected for nicks, cuts, pinch points, and damaged electrical connections that would prevent the signals from being transferred properly to the data acquisition system. Instrument wires should be checked to ensure they are properly strain relieved. A more detailed check of the individual instruments is covered in Section 15- Instrumentation and Wiring.

12.6.2 Mechanical Inspection

Several components in the femur assembly require visual inspection to ensure they are functioning properly. Perform a quick check for any loose bolts in the main assembly. Each mechanical inspection area is covered in detail below. Please contact the manufacturer regarding questions about items that fail the mechanical inspection.

Compliant Bushing: The following checklist should be used when inspecting for post-test damage:

C Check for permanent compression, nicks, or tears

Femur Shaft: The following checklist should be used when inspecting for post-test damage:

C Check for alignment and correct motion in the femur bearing housing.
C Check the condition of the linear bearing lining on the ID.

Femur Skin: The following checklist should be used when inspecting for post-test damage:

- Check for holes, tears, or cuts.

Knee Skin: The following checklist should be used when inspecting for post-test damage:

- Check for holes, tears, or cuts.